

Getting Off the Lifetime Utility Payment Plan



Daren Webster

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The Webster family's solar-electric system produces 100 percent of their annual power needs.

“What! Our Edison bill is \$135? You’ve got to be kidding!” I said when my wife Martina returned from the mailbox. It was 1988 when that bill changed our household. That big electric bill shocked me into looking for a solution.

The very next day, I called Southern California Edison (SCE) for an “energy audit.” This is a free service that SCE provides to their customers. I was so excited when the auditor arrived with his clipboard, calculator, pencil, pen, uniform, etc. When the audit was over and the results were ready, I asked him, “Well, why is my bill so high?” He replied, “Because you have all this stuff plugged in.” I pressed for more,

“What can I do to lower my bill?” He said, “Unplug all the stuff!” Well I knew that wouldn’t work.

Surfing for Solutions

The Internet is such a wonderful thing. First, I found an article from HP14 about phantom loads at www.homepower.com and quickly built a phantom load detector from the plans in the article. This is a very cool device that allowed me to identify

energy gremlins in our home. When you plug an appliance that is “off” into the detector, if a phantom load is present, the LEDs light up. After eliminating the gremlins, our bill went down noticeably the very next month.

Later came compact fluorescents, evaporative cooling, and what I now call “watt swaps.” This is when you remove six, 50 watt bulbs in a bathroom light bar and replace them with six, 25 watt bulbs, or better yet, unscrew three of the 50 watt bulbs so that only three illuminate when turned on. Another example is replacing the 60 watt bulb in the fridge with a 15 watt bulb. My wife didn’t notice the difference! And why does the microwave light stay on when the food is cooking? I thought you were



workshop for our awards business (engraved signs, plaques, awards). I would put the array on the south-facing roof, which has a 22.5 degree, 5:12 pitch. The inverters would be housed inside the shop near the 100 amp subpanel, which would also allow the inverters to be very close to the array.

The size of the system was decided after calculating our electricity usage for our new home over a 17 month

get some PV modules, then dig in with some wire and solder and get this baby going.

After talking to Scott, I was comfortable choosing Kyocera 120 watt panels. They have a 25 year warranty, and they are a well-established company. Next, I needed a couple of 2,500 watt inverters, and Scott suggested two SMA Sunny Boys. I said, "Who, what?" I had never heard of them—probably some "newbie" in

It was *unbelievable* how fast the meter was going backwards.

It was smokin'...

period, and estimating the KWH needed for a future pool and spa. Our average daily consumption was about 18.5 KWH per day with very disciplined usage. We figured 4 KWH additional per day for the electrically heated spa and 2 KWH for the pool's secondary system. (The primary system will use solar powered pumps for the heating and filtering.) Based on real performance data furnished by Scott Carlson of Carlson Solar about existing systems in my area, the calculations determined that a 5 KW system would work. Next, I needed to

the solar arena. Scott told me they are made in Germany. I said, "Cool, do you have a number, or Web address?"

With that information, I had my wife call SMA in Germany and ask all the questions I had written down. She was born in Germany and speaks the language so well that she sometimes still talks German in her sleep! After the translation, I was sold on the Sunny Boys and went down to Carlson Solar to order up my hardware, make my California Energy Commission (CEC) "buydown reservation," and just plain get excited!

Forty-eight Kyocera 120 watt panels and two SMA Sunny Boy 2500 inverters are the major system components.

not supposed to look in there while it's running! I took that bulb out—what a waste.

My Internet searches also yielded many sites on solar and wind-electric systems, and sparked (no pun intended) my interest. The concept of actually eliminating my electric bill was *awesome*! I quickly became an info-hungry, "solarite" wannabe.

From Wannabe to Solarite

Twelve years later, in February 2000, with a plethora of information, saliva building up, and a new 2,450 square foot house on four-tenths of an acre, I was ready to declare myself bill free and start my PV project. Behind the house, I built my 1,000 square foot



Webster System Costs

Item	Cost (US\$)
48 Kyocera KC120-1 PV modules	\$22,185.60
2 SMA Sunny Boy 2500 inverters	3,850.00
Sales tax	2,082.95
8 lengths aluminum angle 2 x 2 in. x 25 ft.	300.00
Misc. conduit, wire, screws, etc.	250.00
2 Disconnects, 30 A	247.20
2 Square D breakers	44.00
Total System Cost	\$28,959.75
CEC Rebate	\$14,479.87
Total Cost	\$14,479.88

Webster System Payback for One Year

Item	Amount
Total energy produced for year (KWH)	9,615
Total energy used for year (KWH)	11,777
Total energy forfeited off-peak (KWH)	1,400
Total energy forfeited on-peak (KWH)	377
Avoided cost	\$2,029
Payback (yrs.), total cost ÷ avoided cost	7

Meeting Scott is a humbling experience in itself. He is the “Shell Answer Man” of solar—very professional, courteous, and beyond informed. In fact, in the picture dictionary under the definition of solar is surely a photo of Scott. He is *solar*! A walking, talking encyclopedia of unending knowledge, he is also 6 foot 7 inches tall. I felt like a wimp at 6 foot, 0 inches standing beside him.

His staff is also very helpful and informed. In addition to the great advice from Carlson Solar, I also spoke on the phone with John Berdner at SMA America. He instructed me to install 24 of the KC120s in series to each Sunny Boy—a total of 5,760 rated watts in the two series strings. This was so cool!

A few days later, the phone rang and my goodies were in and ready for delivery! I was so fired up! A big truck backed up to the garage and unloaded forty-eight KC120s, two SMA Sunny Boy 2500s, two disconnects, some USE wire, and eight, 25 foot (7.6 m) lengths of aluminum angle. “Gentlemen, start your engines!”

I started by cutting the 25 foot aluminum down to 12.5 feet (3.8 m). For each of eight racks, I attached six modules between two of these strips. The L-angles are attached to the outside edges of the modules with the angles facing up and outwards. I put a 1 inch (2.5 cm) air space between each module in the racks to provide more air circulation, since clearance under the PVs was minimal with my rack design.

The airflow helps cool the PV cells, which increases the electrical output of the system. I installed the aluminum racks parallel to the rafters on the roof (vertical orientation) so rainwater would not dam up against the metal as it would if they had been installed parallel to the gutters (horizontally).

The aluminum angles were doubled up on top of each other to minimize the number of holes in the roof (see photo). Because the racks run up and down the roof instead of across, the chances of hitting a roof truss were low, so I through-bolted the entire array, using large fender washers, to the 1 inch (2.5 cm) thick roof. I used ample amounts of sealant around the holes, and especially just above them, to assure that water will be diverted away from the holes.

Connecting each panel was done with UV and moisture resistant #12 (3 mm²) USE wire, with connectors crimped and soldered. Whew, that took some serious time to make 96 soldered connections! Each group of 24 panels is wired in series with only one positive and one negative wire going to the disconnects.

Working with the high voltage for a Sunny Boy inverter is serious business. I wired the modules on the racks inside the garage, out of the sun. There were eight racks of six modules each, all wired in series. Each rack was placed on the roof with positive and negative wire ends capped off temporarily with wire nuts. Four racks were wired to each other to make up the east array, and the other four made up the west array. The final connections between the racks and into the watertight junction box on the roof were made at 11 PM with a small flashlight. And the shinbone is connected to the leg bone!

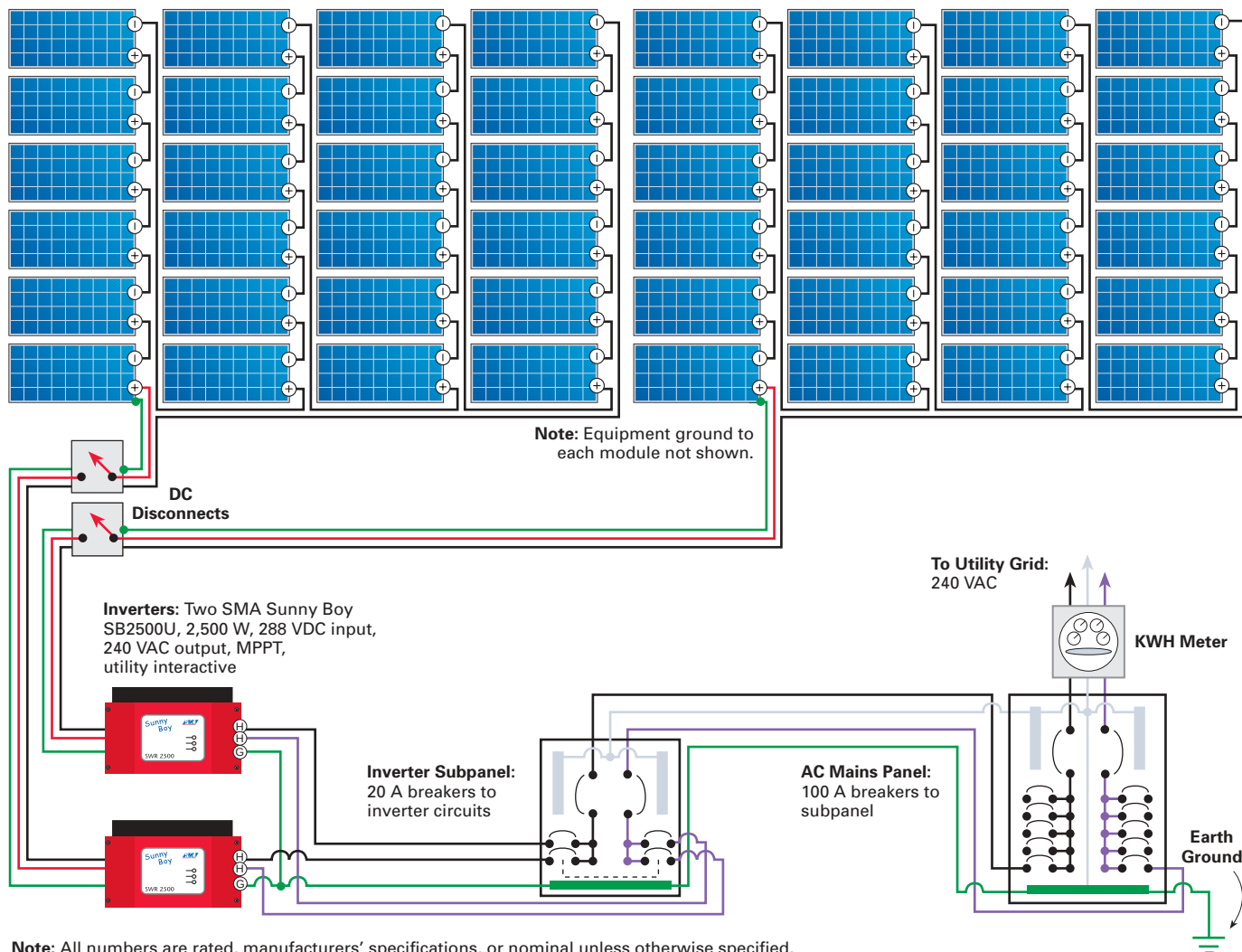
Scott Carlson provided the materials, as well as help in the permitting process, design, and tech support. However, I did the actual installation of the system. If I was a contractor, I would have lost my shorts on this job because it took me a few weeks to install. I had some friends assist in the lifting of the six-panel racks. They were a diverse group of workers, including a homicide investigator (carries a gun), a welder, an IRS agent (nice guy, honest), a software

Doubling up the mounts minimized holes in the roof.



Webster Family Photovoltaic System

Photovoltaics: Forty-eight Kyocera KC120, 120 W each; two arrays, each array wired for 2,880 W at 288 VDC; 5,760 W total



Note: All numbers are rated, manufacturers' specifications, or nominal unless otherwise specified.

**Daren installed his family's PV system himself—
with a little help from his friends and a professional system designer.**

architect (computer geek), a pool contractor, and me (an awards business owner). What a group!

I started running 1/2 inch EMT conduit from the disconnects to the array and installed a small box where the wires are joined. Later, I ran EMT conduit from the disconnects to the SMA input side on one inverter and the output side of the other. I did this for aesthetic reasons. The wires cross inside the inverter, as opposed to outside the unit.

The AC wires were already in the wall and went to the subpanel. I had the foresight to put them there when building the shop. So all I needed to do was install the breakers and connect



the other end to the inverter. To ground the array, I also had placed a #8 (8 mm²) ground wire from the ground rod up through the subpanel and into the attic.

After I finished installing the equipment, I had my solar guru (Scott) come by and bless my work. After 5 minutes, he asked me to switch a wire in the Sunny Boys and stated that when finished I should call the county inspector! *Ta da!*

The inspector showed up two days later and walked up to me and said, "Hi, I am here to inspect your solar system; where are your batteries?" I replied, "I don't have any." He asked, "How does that work?" I answered, "Quite well!" What a goofball. This guy needed to go back to solar kindergarten. Well, he blessed the system and I instantly faxed my job card to SCE for permission to turn on the system.

I received a call from the SCE rep, and I immediately threw the Frankenstein switches, exclaiming, "It's alive!" I then ran out to the meter, with my wife 40 to 50 feet behind me, only to discover that the SMA 2500s would take a few minutes to initialize



The subpanel that the inverters feed is clearly, safely labeled.

Daren chose to mount the SMA inverters inside, even though they are designed to live outside. He added a muffin fan to help them stay cool.



before pushing energy into the grid. I returned to the inverters to watch the countdown, and when the display was approaching zero, I bolted back to the meter and shouted, "We have liftoff!" at the top of my lungs.

It was *unbelievable* how fast the meter was going backwards. It was smokin'... just kidding. Next I had Martina go inside and turn on one of our two, 3 ton air conditioners... and the meter was still going backwards, just more slowly. This was so cool! Then she turned on the second air unit and the meter went forward, but slowly.

Payback Time

I signed up for the SCE time-of-use (TOU) rate, which is based on specific time slots to determine the price of electricity. Basically, we pay a premium from 10 AM to 6 PM on workdays, and discounted rates on

Daren Webster's TOU / Net Billing Computations

From	To	Days	Winter		Summer		KWH Total	Winter		Summer		Energy Charge	Carried Total
			On Peak KWH	Off Peak KWH	On Peak KWH	Off Peak KWH		On Peak Chrg.	Off Peak Chrg.	On Peak Chrg.	Off Peak Chrg.		
09/20/01	10/07/01	17	0	0	-204	35	-169	\$0.00	\$0.00	(\$102.36)	\$4.19	(\$98.17)	(\$98.17)
10/07/01	10/22/01	15	-170	8	0	0	-162	(\$26.51)	\$0.85	(\$24.40)	\$0.00	(\$50.06)	(\$148.23)
10/22/01	11/20/01	29	-269	-19	0	0	-288	(\$41.95)	(\$2.02)	\$0.00	\$0.00	(\$43.97)	(\$192.20)
11/20/01	12/24/01	34	-150	332	0	0	182	(\$23.39)	\$35.26	\$0.00	\$0.00	\$11.87	(\$180.33)
12/24/01	01/22/02	29	-203	188	0	0	-15	(\$31.66)	\$19.97	\$0.00	\$0.00	(\$11.69)	(\$192.02)
01/22/02	01/24/02	2	-15	13	0	0	-2	(\$2.34)	\$1.38	\$0.00	\$0.00	(\$0.96)	(\$192.98)
01/24/02	02/25/02	32	-290	30	0	0	-260	(\$45.23)	\$3.19	\$0.00	\$0.00	(\$42.04)	(\$235.02)
02/25/02	03/26/02	29	-280	0	0	0	-280	(\$43.67)	\$0.00	\$0.00	\$0.00	(\$43.67)	(\$278.69)
03/26/02	04/24/02	29	-315	32	0	0	-283	(\$49.13)	\$3.40	\$0.00	\$0.00	(\$45.73)	(\$324.42)
04/24/02	05/23/02	29	-308	24	0	0	-284	(\$48.03)	\$2.55	\$0.00	\$0.00	(\$45.48)	(\$369.90)
05/23/02	06/24/02	32	-67	-3	-182	125	-127	(\$10.45)	(\$0.32)	(\$91.32)	\$14.95	(\$87.14)	(\$457.04)
06/24/02	07/23/02	29	0	0	-23	604	581	\$0.00	\$0.00	(\$11.54)	\$72.23	\$64.56	(\$392.48)
07/23/02	08/21/02	29	0	0	12	531	543	\$0.00	\$0.00	\$6.28	\$74.91	\$71.59	(\$320.89)
08/21/02	09/23/02	33	0	0	39	817	856	\$0.00	\$0.00	\$20.41	\$115.25	\$124.75	(\$196.14)

As shown in Southern California Edison bill.

Subtotal	(\$196.14)
Amount Owed to SCE	\$0.00
Basic Charge	\$12.14
TOU Meter Charge	\$29.44
Rate Reduction	(\$4.16)
Total Adjustment	\$37.42
Current Amount Due On Bill	\$37.42

weekends, holidays, and outside of the peak hours. The “on-peak” rates are US\$0.52 per KWH in summer and US\$0.17 per KWH in winter. “Off-peak” is US\$0.14 per KWH in summer and US\$0.12 per KWH in winter.

Here’s the punch line—from 10 AM to 6 PM, we are *sellers*, not buyers. The key to using this rate structure is shifting your loads outside of the peak time to maximize the credits that can be generated. Simply put, if you send 20 KWH into the grid during peak at US\$0.52 each (US\$10.40), you can buy back 74 KWH for the same US\$10.40 at the off-peak rate of US\$0.14 per KWH. Too cool!

We went online September 20, 2001 with the TOU rate, and we were able to credit US\$457.04 to our account by June 24, 2002—all the time never having a monthly bill. We had only 3 months left to use the credit *and* the energy still being produced every day. We made a valiant effort to use up the surplus. But on September 23rd, the meter was read, and we had been unable to use all of our credit up. Once we get our spa installed, we will have no problem using up the surplus.

We actually forfeited US\$196 worth. Our utility isn’t required to pay for any energy generated once we offset our annual load. That US\$196 equated to 1,400 KWH off-peak, or 377 KWH on-peak that we could have used if we hadn’t run out of time. However, they sold my energy to someone else—that I am sure of! I wonder how they will show this in their accounting? Maybe they will use an Enron tactic.

The bottom line on all this is that our total energy produced was 9,615 KWH for the year. The total energy we used was 11,777 KWH for the year, and because of TOU, we didn’t have to pay for any of it. My avoided electrical cost from the utility in year one was US\$2,029. When that amount is divided into the US\$14,479.88 cost after rebates,

the simple payback is estimated at 7.13 years. And this doesn’t even include the 15 percent California tax credit for homeowners, or the federal 10 percent business tax credit and accelerated depreciation. I don’t need an accountant to figure out that this is a good deal.

Performance

Though the system has produced as much as 34.5 KWH in one day, the one year running daily average is 26.3 KWH. Monthly average is just over 800 KWH with the annual total being 9,615 KWH. During the middle of a particularly hot day in Hemet, California, where summer temperatures are often well above 100°F (38°C), I noticed that the SMA Sunny Boy inverters were displaying the message, “de-rating,” and electrical output had been reduced. After reading the manuals and having Martina talk with SMA technical staff in Germany (and John at SMA America), I realized that the inverters were simply reducing production in an effort to cool themselves off.

My solution was to add a small, 5 inch (13 cm) “muffin fan” to cool off the heat sinks located on the top of each SMA inverter. Scott (the guru) feels that the fans’ cooling effect



The Websters are a proud, solar powered family!

has increased the system output by almost 5 percent by stopping the inverters' need to derate (slow electrical production) to cool off. Also, electronics like to be cool, and they will probably last longer running at a lower temperature. I placed the fans on a timer so that they turn on only during the heat of the day.

What the Future Holds

Future projects include a PV direct Dankoff pump to push water through several solar pool heating panels and filter the pool for 6 to 8 hours a day. I am hoping to get 10 months of pool usage with no utility bills. Our spa will be heated during off-peak hours using AC.

Justifying my solar projects is easy. You see, it all boils down to a payment plan. You can finance your car for 3 to 5 years, and you understand that when you make the last payment, you are done! Solar is no different. When the system is paid for, you are done. Compare this to the Edison payment plan, which is, "Till death do you part," with their lifelong payment plan. With my solar-electric system, I have prepaid my electricity for the life of my PVs (at least 25 years under warranty), but the payment plan is finished with my 7 year payback. So follow my lead, and call your nearest solar-electric dealer.

Access

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